Modeling by AHP-GIS-based prioritization of Environmental Impact Assessment of oil refineries in Iran: A case study from the Current and Compare of Tehran and Isfahan oil refineries

Mohammad Rezaie Narimisa*  
Iranian Social Security Organization, Azadi St, No 345, PO.BOX; 1457965595

Manouchehr Rezaie Narimisa  
Oil Industries Engineering and Construction Company (OIEC)-Iran, Kamranieh, Pasha Zahri, Pirooz Alley, No 2, PO.BOX; 1937956751

Abstract

In the past few decades we realized that it is not desirable to be only focused on economic or social development without taking into account the environment protection issues. In fact, environmental impact assessment is the study of environmental effects on all environmental, economic and social aspects. Undoubtedly, development of industrial facilities has various negative impacts on the environment and people. In this study during four years four major parameters were considered for Environmental Impact Assessment (EIA) of oil refineries such as; economical, environmental, land use and social during two phase of construction and operation. The Analytical Hierarchy Process (AHP) and Geographic Information System (GIS) were used for EIA of two oil refineries in Iran. In final 1028 maps were provided and after overlaying the all different maps together the EIA of Tehran and Isfahan oil refineries were prepared for their current and compare EIA status. It is very important to have scientific plan for EIA in Iran oil industry. Also it could be done as a modeling draft for other parts of oil industry in Iran. In compare of EIA of these oil refineries we can find the better ways for current and future environmental, socio-economical and land use plans for oil refineries in Iran.

Keywords: Environmental Impact Assessment (EIA), Analytical Hierarchy Process (AHP), EIA, Tehran oil refinery, Isfahan oil refinery, Iran.
Introduction

Recognition of environmental damages, identifying the effects of economic, social and cultural conditions, use of the public opinions in the process of decision-making of the project, identify problems that lead to environmental damages due to the projects; prediction of important environmental impacts, identifying and evaluating the environmental effects of projects before, during and after the implementation. Balance between short and long term goals of developing the oil refineries in line with environmental protection, design software models to assess environmental impact of oil refineries in Iran, according to operational needs in the region. The environmental impacts of petroleum refinery projects have been considered in steps design and construction and operation for physical, biological, social, cultural ambiances. In this project in addition of those parameters some items have been studied that are economical, historical and land use parameters. Recognition of environmental damages, identifying the effects of economic, social and cultural conditions, use of the public opinions in the process of decision-making of the project, identify problems that lead to environmental damages due to the projects; prediction of important environmental impacts, identifying and evaluating the environmental effects of projects before, during and after the implementation. Balance between short and long term goals of developing the oil refineries in line with environmental protection, design software models to assess environmental impact of oil refineries in Iran, according to operational needs in the region. Using appropriate environmental impacts assessment software for specific application in oil refineries in Iran; lessening the negative effects of oil refineries, and speeding up the environmental impacts assessment of oil refineries in Iran with this new software modeling. The research is related to the oil refineries of Iran that are under design-construction or operation, but it should be possible to use the results of the research in future and for other countries. The study emphasis on environmental protection, revised the environmental impact assessment methods in Iran oil refineries, better oil refinery positioning and oil pollution risks. It provides the most accurate advice for the end-users of the system who are engineers, contractors, developers, decision-makers and others in oil industry. Environmental impacts assessment of oil refineries is a new topic for academic research in Iran. Thus, data collection is only from those who are familiar with the related areas of study. It also concentrates on Iran environmental conditions. One construction site located in Iran Tehran oil refinery is selected as a case study. Data is taken from Petroleum Ministry of Iran, Tehran oil refinery for site characteristics, construction and operational stages and environmental monitoring. Data collection is done for site map, construction and operation stages, and environmental status within the site, baseline data, environmental quality monitoring, standard level, site area air quality monitoring, oil content monitoring and solid waste measurements. The important environmental quality monitoring parameters considered during construction and operation activities are results for measurement reports of environmental quality related to site area including oil content monitoring, air quality measurements reports, solid waste measurements reports. In fact, environmental impact assessment is the study of environmental effects on all environmental, economic and social aspects. Undoubtedly, development of industrial facilities has various negative impacts on the environment and people. Often these problems are not related to the development or technologies themselves, but they are related to environmental problems that follow. Due to the attraction of Tehran’s ecosystem the city has been focusing on widespread use of land, water when developing. Because the premature development without environmental evaluations can have undesirable effects on the environment and the welfare of human beings, it is dependent on doing
environment impacts assessment through using technology and by taking into consideration the inter-relationship between development and environment conservation. This way we can achieve a sustainable development. In the past few decades we realized that it is not desirable to be only focused on economic or social development without taking into account the environment protection issues. Hence the concept of sustainable development and environmental impacts assessments were introduced to have a balance between industrial advancement and environmental protection and environmental impacts assessment of oil refineries and its related land preparation tools of sustainable development plans came into consideration. If site selection for oil refineries can be based on ecological, social and economic needs, oil refinery projects will run with less environmental costs. Solving environmental issues are relatives to improving conditions in the environment management system and using new methods and develop environmental impacts assessment regulations and standards related to it. Governments in the Islamic states should provide for executive, legislative and judicial apparatus that are in line with the Sharia laws to make sure that functions such as production, distribution and consumption are done properly. One of the main tasks of a government is to protect the environment and to provide ways to utilize renewable sources so that next generations can also benefit from those kinds of resources that are not renewable. The second task on the shoulders of government is to make sure that privately owned usable sources be used in a way that does not have negative impacts on the environment. Governments should provide for policies and legislations that strike a balance between development plans and environment protections in a way that both maximize the productivity of societies and the establishment of justice. The aim is prediction, identification of probable problems and detailed analyses about the impacts of the projects on the environment. Generally, oil industries can cause differing degrees of quantitative and qualitative impacts on the environment. In many countries in recent decades, researchers, environmental tools and techniques used to help related staffs have been utilized to identify an appropriate way of oil industry development plan with the least amount of negative impacts on the environment. This research is about rules, guidelines and standards about environmental performances and actions. In current urban population growth and rapid development special attention should be given to the environment in urban areas and oil industry related installations. For provide a view point of Iranian oil refineries development plans, strategic planning in the oil refining, establish new oil refineries companies in Iran needs to know the EIA of oil refineries in IRAN. A survey of topical records of developmental plans and projects such as refineries in the country shows that in the past developmental planning’s, as is the case in many developing countries, environmental issues and values were overlooked and many such plans have been put into operation without environmental protection issues being in mind. Environmental impacts assessment is an acceptable method to fulfill the objectives of a sustainable development. It is a vital tool at the hands of planners, managers and decision makers for identifying and reducing the adverse impacts development programs may have on the environment. Worries about the impacts of carrying development projects are increasing. Governments and international organizations are after regulations to legally oblige employers of projects and development planners to produce environmental impacts assessments. The environmental assessment is regarded as a mechanism that offers correct and logical ways to utilize human and natural resources in an economic and efficient way. It has considerable positive effects on our short-term or long-term plans. The awareness among the public will also be increased because the assessments are in relation with planning procedures.
Assessment report for EIA (for construction and operational stages)

Base on the Iranian refining planning and future views two parts (construction and operational stages) of these are being considered in this project. The production of an assessment report is the job of the employers of the plans or projects. To economize on expenses and time, the order of producing the assessment report, its being approved, obtaining or failing to obtain the permit for carrying it out is as follows:

1- Management and systematization
To produce an assessment report an employer would do it in his or her own if she or he has a consultant. Otherwise, she or he would have to be the party of a contract with an authorized real or legal entity.

2- Timing of the studies
The time required to produce an environmental impact assessment report depends on the type, size and complexity of the project. It also depends on geographical and social conditions of the place where the project is going to be carried out. Other factors that affect the time of report production are the amount of the budget, the ease of access to the required information and the efficiency of the consultants. Usually the required time is between 4 to 8 months.

3- Financing and expenses
That fact that the cost of producing reports is high especially for big projects such as refineries is a cause of serious concern. The cost of report production depends on the complexity, importance and the place of the project. It also depends on ease of availability of required experts.

4- Determining the limits of studies
To determine the limits of studies and the extent of geographic impacts of the project is one of the most factors to reduce the costs. It also helps to recognize the exact consequences, to remove ambiguities and complexities, and to gain access to the required information. The main factor in determining the limit of studies is getting familiar with the activities of a suggested plan or project. To do the job of environmental impacts assessments of refineries properly, it is essential to utilize the expert opinions of the related specialists, or related governmental organizations as well as the scientific and research institutes. In doing so, we can mention holding sessions with these specialists and these organizations. Determining the geographical impacts of the studies is one important factor in producing the assessment reports.

5- One of cases that assessment report preparation is important definition of geography studies scope.
Definition of place scope or studies geography scope according to limiting sources base done time and human force is defined in assessment of studies for important impacts defining is done placing scope of studies environmental impacts assessment base done geography boarders as following:
Offering projects limits
Determining the geographical limits and scopes of the studies is affected by the limitation of time and workforce. By projects’ geographical limits we mean the setting in which the construction preparation activities, construction activities and operational work of the project in
done. It is exactly from this setting that environmental impacts are posed. The geographical limit or scope of the studies on the environmental impacts assessment is done based on the following geographical limits:

6-Ecological limits
By ecological limits, we mean the extent of the spread of the project’s emissions into the environment through the air or water that could lead to negative effects. Also by ecological limits, we mean the areas of the projects that have impacts on the project’s activities from ecological points of view.

7-Social limits
By social limits, we mean social interactions between structures and social systems that are affected by the activities of the projects. Of the three limits of the study, the social limit is the most important one, because the socio-economic life of many social groups are negatively or positively influenced by the different activities of the projects or plans. That is why in producing environmental impacts assessments we should deal with these effects on the lives of different social groups.

8-Administrative limits
By administrative limits, we mean the level to which people of a society can freely embark on economic, social and cultural activities within the scope of their laws and regulations. In other words, these limits are the administrative and governmental beaneries within which people can maneuver, such as the permits issued to make use of forests or mines.

There are some other technical limits for studies, such as the amount of budget, time and workforce; so, these also should be taken into consideration.

The above-mentioned limits, can determine certain geographical boundaries. So, with regard to the available information, timing of the project, the amount of budget provided for producing the assessment report, professional workforce, technologies’, and the methodology the producers of such reports are obliged to set the geographical limits in the studies within ecological, social and administrative limits.

To determine the areas of responsibility, and to be able to predict the impacts of construction and operational work of the projects or plans it is vital to utilize a matrix. This way you can accelerate the studies, speed up the selection of specialists, and avoid gathering parallel (unnecessarily repeated) information and save expenses. A matrix is a simple credible tool that enables specialists as well as other related people who are not technicians but are anyhow involved in the environmental and managerial aspects of the projects to identify the oncoming phases of the projects, hence resolving problems related to the shortage of information and determining ways to reduce the impacts.

Previous experiences from studies done on the environmental impacts assessments shows us that in some meetings and in completing some matrixes, because of the creation of many environmental problems, the work of producing environmental impacts assessment report was stopped and the conclusion of experts was that the reason for stopping the studies was due to lack of technical, economical or ecological solutions in all the options of the site selection, project construction and operation.
Determining the details of studies services

Some international organizations have provided and published different samples of the details of studies services done for refineries’ environmental impacts assessments. The type of these kinds of plans and projects are provided by the Management and Planning Organization of Iran or by technical offices of related governmental organizations.

(i) Providing the basic required information:
Based on the findings, the preliminary detailed list of identifying of the impacts can be known about in the phase of determining the scopes of the works, depth of the study, data needed, statistics and information. Naturally, the producing of information is costly. On the other hand, based on the type of the methods or methodologies applied in the assessment, you will need varied basic information.

To reduce costs and time of studies, and to prevent parallel work (repeated unnecessary work), you can make use of information available in governmental or semi-governmental organizations.

(ii) Writing the report
When producing reports, two types of reports should be produced. One is a brief report that should be done according to the contents of Article 5 of the Environmental Assessment Regulations. Another report is called “environmental impacts assessments” that should be produced based on the contents of Article 6 of the just-mentioned regulations.

The draft of a EIA oil refinery in Iran should have these items:
A- Brief assessment report:
To exercise an accurate and substantive management on the production of the brief assessment report, it is necessary to comply with the guidelines in the assessment regulations.

B- Environmental impacts assessment report:
The contents of an “environmental impacts assessments” report for refineries’ should include as follows:
• Non-technical summary
• Defining the plan or the project
• Explaining the current ecological conditions of the project location
• Predicting the environmental impacts of different options
• Assessing all the options
• Plans of measures to be taken to reduce negative impacts
• Plans to manage the environment
• Summing up and conclusion
• References and sources
• Report on the qualifications of the providers
• Appendices

(iii) Non-Technical Summaries
The summary non-technical with aim prevent of irresponsible ambiguity, decision making maker and beneficiary of groups that no avail themselves from environment expertnesses is forming therefore included topics in non-technical of summary must have been writing simple characteristic, and if possible is devoid of technical and science.

(iv) Defining the plan or the project
In this part of the report, which is mainly an introduction of the project or plan, items such as different justifications, different phasing of the operations and different options are reiterated.

(v) Explaining the current ecological conditions of the project location
In this part, the ecological conditions (physical, biological, economical, social, and cultural) of the site project and the impact of the project on them are dealt with. This part needs employment of experts, because it is a complex, important and costly process that needs search or production of basic information.

(vi) Predicting the impacts of the projects or plans
The impacts of refinery projects differ in their intensity, prominence and scope in their different phases of constructions or operations. To assess the refineries’ impacts different effects should be analyzed. The main items of these are:
- Irrevocable impacts, such as the distraction of the habitats of endangered species
- Renewable impacts, such as making use of rivers
- Positive effects, such as creating employment opportunities
- Certain negative impacts, such as emission of dangerous substances
- Short-term impacts: such as bothering noises in the phase of the construction
- Long-term impacts: such as the noise made when loading or unloading products or equipment at site
- Strategic impacts: such as causing change in the ethnic structure of the place where the projects are being carried out.
- Initial impacts: such as increase in the amount of sediments created during the construction work
- Secondary impacts: such as disturbing the ecological balance of the rivers during the construction phase of the project
- Thirtiary impacts: such as a reduction in the amount of fish catch by the fishermen
- Indirect impacts: such as an increase in the revenues of the locals
- Direct impacts: such as job creation for the locals
- Accumulative impacts: such as emission of waste water containing fuel oil in the rivers, lakes or streams near the refinery where the amount of oxygen in water is low.

To anticipate general impacts of a refinery we should take into account the followings:
A-The physical and chemical environment
- Certain impacts of the activities on the climate that cannot be overlooked
- Certain impacts of the activities on the quality of soil that cannot be overlooked
- Certain impacts of the activities on the stability of soil that cannot be overlooked
- Certain impacts of the activities on the environmental erosions in the vicinity of the refinery that cannot be overlooked
- Certain impacts of the activities on the topography of the land near the projects that cannot be overlooked
- Certain impacts of the activities on the rivers, streams or underground water that cannot be overlooked
- Certain impacts of the activities on the patterns of drainage of water that cannot be overlooked
- Certain impacts of the activities that may cause flood or landslides
- Certain impacts of the activities on the quality of air and the amount of pollutant emissions into the air that cannot be overlooked
- Certain impacts of the activities that increases air pollutants and affect the provision and quality of the water used for consumption in the area that cannot be overlooked.
- Certain impacts of the activities from the view point of intensity, scope, significance and state of the pollutants in the air
- Certain impacts of the activities from the view point of intensity, scope, and the significance of the provision of and access to surface or underground water
- Certain impacts of the activities on hydrology and hydrographic in the region from the view point of regime, current and direction
- Certain impacts of the activities on the present laws and regulations about water sources
- Certain impacts of the activities on the quality and quantity of the surface and underground waters in the areas near the refineries
- Certain impacts of the activities on changing the course of waters from one water field to the other
- Certain impacts of the activities on the coastal waters in lakes or seas
- Certain impacts of the activities on fish catch and the extent of this impact
- Certain impacts of the activities from the view point of the emission of dangerous substances into water reservoirs near the area
- Certain impacts of the activities on the increase in the amount of the sediments in water reservoirs
- Certain impacts of the activities on the temperature of the waters in the area near the refinery
- Certain impacts of the activities from the view point of bothering noises for humans
- Certain impacts of the activities from the view point of bothering noises for the wildlife
- Certain impacts of the activities from the view point of the increase in the solid waste materials
- Certain impacts of the activities from the view point of the type and qualitative properties of solid waste materials
- Certain impacts of the activities from the view point of the increase in the amount of dangerous waste materials
- Certain impacts of the activities from the view point of the effects of the dangerous waste materials in the environment
- Certain impacts of the activities from the view point of the increase in heat, waves, electricity, radioactivity, vibrations and the extent of turbulences
  • Impacts on climate and weather quality
  Certain effects of some activities such as using vehicles, constructing work and increase in the emissions can lead to changes in microclimates in the areas near refineries. The creation of smog can cause diseases or even death in people with heart or lung ailments who live around. An increase in the amount of dust and other particles in the air can reduce the visibility that in turn affects activities. Reduced visibility also means less sunlight that damages the plants nearby. We can classify the impacts of the pollution into different facets such as impacts on health, economy, society, and plants. The amount of the pollutants in the air should be analyzed while constructing or operating different sections of the projects and its impacts have to be explained.
  • Impacts on the quantity and quality of water sources
  Physical activities such as changing the course of rivers can lead to ecological changes. In addition, accumulation of sediments can change the course or depth of the rivers. Releasing wastewater into the rivers or lakes affects the marine life there. Using water for different purposes leads to a reduction in underground water sources that can in turn have negative impacts on commerce, wildlife and recreational activities. Irregular water current may also lead to floods or rivers being dried out. Plants are very sensible to the change or decrease in water. Whether we are in construction phase or in operation phase of the refineries, we should take into...
account the quantitative or qualitative impacts these activities may have on the environment; so, we have to anticipate these impacts.

- Impacts of the noise
The level of noise in construction or operation work of the projects is certainly higher than before. In the construction phase, noise can come from vehicles that come to the site. For example, a stonebreaker can cause a lot of noise. In operation phase also there is noise. The noise is from different vehicles that are used to transport products or personnel to and from the site. The noise can be a great cause of trouble for those who live near the sites.

B- Biological Environment
- Certain impacts
The activities on the flora of the environment, fauna of the environment marine life, food chain of the environment, natural ecosystems, wildlife and marine life, plant life in the area, animals’ habitats in the area, life of important species of plants in the area (from IUCN list), life of important species of animals in the area (from IUCN list) biodiversity of the region.
- Impacts on plants
Direct impacts of the projects on plants are in the form of excavating earth or constructing a new access road during the construction of the project. Cutting trees or plants for the purposes of burning or road construction are some activities that are usually done during such projects. Indirect impacts can be soil contamination, change in the level of underground water, altering the chemical property of soil from alkaline into acidic. These impacts on plants can lead to changes in microclimates of the areas nearby. Plants can be affected clearly by different activities of the projects. The creation of dust in the air due to construction or operation work of the projects is an example of how the environment can be affected. A reduction in the population of plants and trees can affect the population of animals and humans and can cause people or animals to migrate to other places. People who live nearby may have to go somewhere else in search of jobs. Animalistic of kinds also to reason to lose own habitats or losses and or perforce to will was find new habitats and asylums that can condition own ecological in it find.
- Impacts on Animals
Environmental changes due to projects can affect not only one kind of animal but it can affect the lives of many other animals, as animals are connected to each other through food chains. For example, marine life is very sensible to the thermal or chemical changes in waters. Releasing warm wastewater or water containing industrial wastes, and water containing chemicals or fertilizers can damage the balance of ecosystems greatly. Indirect impacts such as change in fish population due to too much fish catching, changes in the places where the fish lay eggs are all the consequences of disturbing the eco balance of the environments. Generally, in case it is possible, we should employ quantitative methods to explain the biological impacts of the projects; otherwise, qualitative methods can be employed.

C- Socioeconomic environment
1-Certain impacts of the activities on the current or the future uses of lands
2-Certain impacts of the activities on the economic bases
3-Certain impacts of the activities on their traffic movement
4-Certain impacts of the activities on the increase, decrease or concentration of the population in the area
5-Certain impacts of the activities on the job opportunities
6-Certain impacts of the activities on the settlement or movement of the population
7-Certain impacts of the activities on the quality of life of the locals
8-Certain impacts of the activities on the commercial, economic, industrial and mining patterns
9-Certain impacts of the activities on the incomes and expenses
10-Certain impacts of the activities on the social unity and cooperation
11-Certain impacts of the activities on the expansion of energy production, transportation and consumption plans
12-Certain impacts of the activities on tourism plans
13-Certain impacts of the activities on the use of lands
14-Certain impacts of the activities on health, education and administrative services possibilities

Impacts on Economic- Social Environment

Different construction and operation work of the projects affect the socioeconomic state of the areas nearby. Air pollution, for example, can affect the population in the area. The project itself can attract some people in search of jobs. The increase or decrease in the population, due to the project, can affect the economy of the area. In addition, social life of the people who live nearby can be affected. In case of population growth in the area, need for other services and facilities increases as well. For some projects there may not be a need for a new road, so an already existing road can be used. In this case, the traffic would increase leading to more cases of accidents and related problems such as long delays. In some other projects, there may be a need for constructing new residences for the personnel of the projects. This also can lead to environmental negative effects. As new settlement needs a sewage system; they also need water, etc that can have negative environmental consequences. Other impacts of such projects are the reduction of property prices near the refineries. Because due to air and noise pollution the price of the residences nearby go down and people will leave the area in search for better places to live. This in return can cause an increase in the price of properties in other places where people are more willing to live in.

D- Cultural Environment
1- Certain impacts of the activities on places of historical value
2- Certain impacts of the activities on ancient places
3- Certain impacts of the activities on religious places
4- Certain impacts of the activities on places that have architectural peculiarities
5- Certain impacts of the activities on places of heritage
6- Certain impacts of the activities on touristy places
7- Certain impacts of the activities on social institutions, services, hygienic, educational and administrative facilities

Impacts on Cultural Environment

Places of cultural value can be affected by such projects. Places such as tourist attractions, historical and ancient places, religious and cultural venues, etc. Therefore, it is vital to predict whatever negative consequences these projects may have on these places, because these places have local, regional or national importance.

The impacts on landscapes with regard to soil, water, plants and animals should be subject to assessments. Landscapes are important to people from the viewpoint of aesthetics, as well. A
change for the bad in the morphology of the coasts can result in reduction in tourists. Cutting trees, and damaging green fields’ ruins natural landscapes.

The EIA researches in the field of oil industries were carried out so that the results can be useful for other parts of oil industries in Iran same as oil refineries and oil terminals (Ghizhanzadeh, 2005). The challenge of collecting, processing, analyzing and reporting information can be partially met by the use of various computer and information technologies (computer-assisted systems) (Muthusamy and Ramalingam 2003). In the past the environmental impacts of refineries were given very little attention in developing countries but now they are gradually coming into the focus of attention. And now refineries are considered as those projects with short-term and long-term effects on the environment (Momenzadeh 2006). The goal of this evaluation software model for environmental impacts assessment for oil refineries is to make sure that we are in line with sustainable development and that our economic objectives will be followed in a way that the least amount of destruction is done to renewable and non-renewable resources (Monavarie 1999). Therefore, we must see environmental problems from a wide perspective and law makers should create laws to make sure that the development of infrastructures in Iran as well as the economic development be achieved with environmental protection issue being kept in minds (Shariat 2001). Therefore, it is important that products designers have access to relative environmental information so that they can make appropriate decisions and trade-offs with other design requirements (Park & Seo 2006). The decision-making on approval of environmental impacts assessment (the EIA) is an intrinsically complex multi-dimensional process because it does not only consider the scientific facts but it also reflects subjective values (Liu & Lai 2009). A development proposal for which there is concern of adverse impact on the environment should prepare an environmental impact statement (the EIS) for the first-stage of the EIA, and then transfer the EIS to the competent authority for review (Liu & Yu 2009). Life Cycle Assessment (the LCA) allows the estimation of the environmental impacts of a process or product. Those environmental impacts depend on how efficient these operations are carried out (Lozano et al. 2009). Previous studies have examined the Cumulative impacts assessment efforts at the federal level but little is known about how states assess the cumulative impacts of nonfederal projects (Ma et al. 2009). Due to better environmental practices, water use, and especially the release of contaminants into water resources, as well as air emissions (due to very efficient dust management), are reduced considerably (Mangena & Brent 2006). Problems of environmental decision making are intrinsically complex because they almost always involve multiple aspects the relative importance of which needs to be determined by subjective evaluations (Marttunen & Haimailainen 1995). In the beginning, the integrated environmental assessment framework was designed to incorporate public participation and consisted of four phases: 1) screening; 2) scoping; 3) determining significance, improvement and follow up; and 4) recommendation, to enable decision makers to make informed decisions regarding the potentially significant environmental and human health effects of an industrial development (McCaig 2005). Environmental impacts assessment (the EIA) has been, and remains for the time being, a very important tool of environmental management - although not always for the reasons one would expect. Major achievements of the EIA have been through indirect benefits that have been given little recognition to date, particularly the achievements of its simulative and educative roles (McDonald & Brown 1995). Environmental Assessments is a multidimensional problem and depends on domestic and local characteristics of each case study,
so these kinds of overall assessments should be considered as first step and just a total evaluation (Mirmohammadi et al. 2009). Possible definition of sustainable development is therefore: ‘A system has a sustainable development if that development enables it to maintain its wholeness as an integral system, whilst also maintaining its role as part of a larger system on which it depends’ (Nooteboom S., 2007). Such arenas should be; defined by a broad mandate and instruction, characterized by key personal skills and resources, and build institutional capacity for a range of stakeholders to engage with them (Nykivist & Nilsson 2009). Thus such a focus would not only enhance understanding of the EIA, but also represents an important contribution to knowledge regarding public participation in policy making generally (OFaircheallaigh 2010). Each EIAs level consists of a full description of the physical, biological, and socioeconomic characteristics of the site where the project is to be developed, a full description of the proposed project activities, and an assessment of the interactions, negative or positive, among the proposed activities and the environment (Ortega-Rubio et al. 2001). Theoretically, one must investigate the impacts of all possible indices in each EIA. In the future study, detailed data such as waste composition, technology and equipment must be taken into account (Pai et al. 2008). Environmental impacts assessment (the EIA) evolved as a tool to assess the likely impacts, both beneficial and adverse, of a proposed development project (Parashar et al. 1997). Lessons from Spain’s public participation in the EIA is conducted simultaneously with disclosure of the project intent, and by doing so, the first is very much conditioned upon the acceptance of the project (Pardo 1997). Indicators are the bases of the different methods of environmental impacts assessment (Payraudeau & Werf 2005). One of the most important prerequisites in environmental impacts assessments (the EIAs) is that the evaluation and communication of impacts must be done with objectivity and transparency. Traditional methods as checklists, matrices, geographic information systems (the GIS), and cause-effect diagrams fail to reach this objective because, in general, it is difficult to follow the assumptions and rationale behind the evaluation process (Perez-Maqueo et al. 2001). Today there is a great variety of methods for evaluating the environmental impacts of plans, programs and projects. But which of these methods should planners and managers choose? This theoretical article explores the connection between conflicts, communication and rationality in assessment methods (Persson 2006). The difference that forms the basis for an assessment of how environmental information provided during an EIA process contributes to environmental perception (Peterlin et al. 2008). It is generally recognized that one of the major objectives of an EIA system is to provide for projects licensing, or planning permission, with sound, relevant and social responsive technical and scientific knowledge on the likely environmental effects of a particular development proposal (Pinho et al. 2007). The potential advantage of a decision-oriented theory of environmental assessment have long been recognized, but it is only in recent years that this topic has received intensive attention (Pischke & Cashmore 2006). AHP approach is a multi-criteria decision making method that is suitable for dealing with complex systems to choose from among several alternatives which provides a comparison of the subdivision of the problem in the hierarchical form. This tool can be used for analyzing different kinds of economic, social and technological problems. Several papers have compiled the AHP success stories in very different fields and areas (Ishizaka & Labib, 2009). The vast majority of the applications still uses AHP and is unaware of successive developments. This fact is probably due to the leading software supporting AHP, Expert Choice (EC), which still incorporates AHP (Ishizaka & Labib, 2009). The goal of ES development effort is supposed to be a workable system for production use

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During the prototype begins function satisfactory, the system performance criteria can be defined for developing system (Negnevitsky, 2005). User involvement in design and implementation of expert systems is generally encouraged in the literature, but actual involvement of users in expert systems development is usually ignored (Azadeh et al., 2009). The answers to these questions are used as input to determine the element or factor (Yang et al., 2001). As the project proceeds the ES needs to be periodically tested and evaluated to assure that its performance and results are converging toward established goals. ES testing and validation are vital before their effective employment in the intended user environment; therefore, system validation has received considerable interest among many AI researchers (Er & Dias 2000; Mosqueira & Moret 2000). Testing involves program debugging, error analysis, input acceptance, and output generation. Validation concerns the diagnosis of how closely the ES solutions match those of the human experts, whilst user acceptance concerns with issues that impact how well the system addresses the needs of the user (Er & Dias 2000). An ES models the decision making of a human expert. If it is correctly designed, the system derives the same results as the expert and reasons in a manner similar to the expert. Therefore, evaluation efforts should address the following: validate the system's results, reasoning process, and user acceptance (Durkin, 1994). Verification is concerned with the system that is built and implemented correctly. In addition it is relevant that logical structure of the expert system and input parameters are represented correctly. In order to verify expert system, testing levels can be used such as system testing, unit testing, and integration testing (Aguilar et al., 2008). A special questionnaire is designed to help acquire information with respect to the system. It covered several sections, addressing topics such as the knowledge acquisition techniques, knowledge base contents, explanation facility, speed of decision-making, system recommendation, and help facility (Lee et al. 2008), improvement the speed of strategic decision-making, confidence about the advice or recommendations (Li & Li, 2009).

Material and methods
Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a multi-criteria decision making tool for dealing with unstructured, complex and multiple-criteria discrete decisions (Partovi, 2007). AHP has been successfully applied to a diverse array of problems (Chang et al., 2009). The use of AHP is suggested to solve the problem of independence among alternative or criteria (Dagdeviren et al., 2008). The basic theory of AHP is the condition of functional independence of the upper part, of the unidirectional hierarchy, from all its lower parts, and from the criteria or sub-criteria in each level (Dagdeviren et al., 2008). AHP is easy to use but it is strong, such that it can handle the complexities of real-world problems. AHP is a technique that decomposes a problem into several levels of components in such a way that they form a hierarchy. The top element of the hierarchy is the goal for the decision making (Erdogmus et al., 2006). The elements affecting the decision are called criteria, and the criteria can be subdivided into sub-criteria. The lowest level comprises the alternatives as shown in Figure 3.6 (Partovi, 2007). Decision making begins the prioritization procedure to determine the relative importance of the elements in each level. Elements in each level are compared pair-wise with respect to their importance to an element in the next higher level in a hierarchical structure. Starting at the top of the hierarchy and working down, a number of square matrices (preference matrices), are created in the process of comparing elements at a given level (Partovi, 2007).
Furthermore, this approach assists the user to appraise the importance of each criterion in relation to the others in a hierarchical structure (Li & Li 2009; Levary & Wan 1999). After forming the preference matrices, the composite weights of the decision alternatives are determined by aggregating the weights throughout the hierarchy. Aggregation is done by following a path from the top of the hierarchy to each alternative at the lowest level and multiplying the weights along each segment of the path. The outcome of this aggregation is an overall weight for each alternative (Partovi, 2007).

**Geographical information system**

For long time, people have studied the world using models such as globes and maps. In the last thirty years, it has become possible to put these models inside computers; more sophisticated models into smaller computers. These computer models, along with the tools for analyzing them, make up a Geographic Information System (GIS) (Ormsby et al., 2004). GIS is a computer system for collecting, checking, analyzing, and integrating information related to the earth surface (Krpo, 2004). This system is able to collect and use data related to different location of earth (Navaie Toranie & Adeli Nia, 2004). In fact GIS helps the managers, programmers, engineers, and everybody implementing data as a type of system for management, analyzing, and show data and results (Saadi Mesgari & Ghods, 2005). Therefore, it is a useful tool for integrating data and information, and assisting in decision-making (Liu et al., 2007) that means the purpose of GIS is to provide an objective support for decision making based on spatial data (Taboada et al., 2006). GIS is a powerful software technology that allows unlimited amount of information to be linked to a geographic location. Coupled with a digital map, GIS allows users to see locations, features, events, and environmental changes with unprecedented clarity. In addition it displays layer upon layer of information such as environmental trends, pesticide use, soil stability, hazardous waste generators, dust source points, migration corridors, Lake Remediation efforts, and at-risk water wells. Effective environmental practice considers the whole spectrum of the environment. GIS is used in the entire world. Use of GIS in Europe started for registration of properties documents and preparing of environmental data base. In England the biggest user of GIS is services work such as telephone, water, electricity, gas, and preparing the geographical data base. Users usually implement GIS for monitoring and modeling regarding environmental changes such as in Japan and China. In addition nowadays GIS is used in environmental monitoring, environmental pollution, and protection of water resources for the entire world (Navaie Toranie & Adeli Nia, 2004).

In this research GIS-EIA system modified and designed for Environmental Impact Assessment of oil refinery in Iran as Tehran oil refinery has been selected for EIA. In this part of research for two case studies as Tehran oil refinery in four parts of economical, environmental, land use and social items have been considered to provide complete environmental impact assessment results for them. Base on the researches in the part of economical three items have been considered as; workshops, industrial equipments & material shops and economical knowledge. In part of environment; local environmental changes have been considered for better results. In the part of land use; changing the usage of natural resources and use the lands around the oil refinery for site preparation and effect of oil refinery on the land use changing have been considered to complete the land use part in the field of EIA of oil refinery. In the part of social; cultural effects, Environmental knowledge and historical problems have been considered for effects of these oil refineries on the population parameters and results of them in the field of EIA oil refineries. All
of these researches based on the EIA Tehran oil refinery in two parts: construction and operation. For each refinery 100 effective maps provided for Tehran refinery in two phases as construction and operation in four general classification as; economical, environmental, land use and social parameters. As specified in each study area, the latitude and longitude of each point of the area was recorded by using a GPS. By using the software Arc GIS 9.3 point data were converted to the regional data. Using the interpolation method, the parameters of the raster maps were prepared. The produced maps were combined together and with respect to the software classification model, different maps were drawn. For better results maps based on geographic location and characteristics of the nature of the information or forms built on land boundaries are identified in the study, were drawn. Also raster for map drawing has been considered as information which distinctive visual elements (multiple layers) are displayed (pixels).

Then for complete the EIA study data integrity done as, data integrity means that using one or multiple databases, multiple tables with multiple layers of information, the information can be viewed on a map. In the next step maps were drawn as, view single physical forms part of the surface which is graphically displayed on a flat surface. Drawings signs, symptoms, and spatial relationships between the forms show. All maps provided with zooming capability in order to view details parts of geographic information big and bigger. For better analysis in EIA-GIS system in the maps data integration has been considered as, data integration means using one or multiple databases and multiple tables and data layer, the information can be seen on a map. In the next phase polygon of the maps for EIA results provided as, a polygon shows that the area on the map and the form of the curve that it can be defined with it.

**Calculate the index weights based on judgment and decision making paired comparisons**

To use this method, the matrix of paired comparisons is formed as indicators of the relationship.

\[
D = \begin{bmatrix}
    a_{11} & \cdots & a_{1n} \\
    \cdots & \ddots & \cdots \\
    a_{n1} & \cdots & a_{nn}
\end{bmatrix}
\]

\[
W = \begin{bmatrix}
    W_1 & \cdots & W_1 \\
    \cdots & \ddots & \cdots \\
    W_n & \cdots & W_n
\end{bmatrix}
\]

In this matrix \(a_{ij} \rightarrow \forall i, j = 1, 2, \ldots, n\) represents the personal judgment of the decision maker about the comparison between the pair of indices \(i, j\) index is \(i\). In other words, a decision maker can be with respect to the index \(i, j\) indices have different importance and priorities. For example, it can have the same importance, or rather is much more to use it, it is first preferences to the table 1 and then used a little.

**Table 1** Scale to quantify the qualitative criteria

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Definition</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element (i) to element (j) are equally important</td>
<td>Equally Preferred</td>
<td>(a_{ij}=1)</td>
</tr>
<tr>
<td>Element is a rather (i) to element (j)</td>
<td>Moderately Preferred</td>
<td>(a_{ij}=3)</td>
</tr>
<tr>
<td>Element (i) is much prefer the element (j)</td>
<td>Strongly Preferred</td>
<td>(a_{ij}=5)</td>
</tr>
<tr>
<td>Element (i) is very much prefer</td>
<td>Very Strongly Preferred</td>
<td>(a_{ij}=7)</td>
</tr>
<tr>
<td>Element i is very much preferred</td>
<td>Extremely Preferred</td>
<td>$a_{ij} = 9$</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Intermediate values Preferred</td>
<td></td>
<td>$a_{ij} = 2, 4, 6, 8$</td>
</tr>
</tbody>
</table>

On the other hand $\frac{w_i}{w_j}$ is representative of the actual weight index i to index j that the values are unknown and must be determined. With little attention is given:

$$\forall i = j \rightarrow a_{ij} = 1$$

The formula is expressed as a ratio to its significance is the same. On the other hand:

$$a_{ji} = \frac{1}{a_{ij}}$$

If the index value index i to index j form decision maker is equal with $a_{ji}$ then the value of index I to index j will be reverse of it and it means $\frac{1}{a_{ij}}$.

For a paired comparison matrix non measurement scaling in this method, each component of the overall decision-making matrix is divided into components corresponding number column. This is the mathematical form of the case.

$$(j=1, 2, ..., n) \quad \text{and} \quad n_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}$$

In this formula $n_{ij}$ is representing the normalized value of index i to index j.

**Consistency of judgments**

One of the preferences of analytic hierarchy process is the possible consideration of consistency of judgments compatibility in for determine the criteria’s and sub criteria’s. On the other hand in twin criteria matrix how much, consistency of judgments was observance. When the importance of criteria’s estimated as compared with each other, it is probable the imperfect in judgments. It means if $A_i$ is more important than $A_j$ and $A_j$ is more important than $A_k$, as a rule it should be $A_i$ is more important than $A_k$. But in spite of all efforts preferences and feelings of decision makers most of the time are imperfect and innumerous. Then it should be finding the index that visible the amount imperfect judgments. The mechanism that considered for imperfect in judgments is the calculation of coefficient named incompatibility coefficient (IR) that obtain from divided incompatibility index (II) to collision index (RI). If this coefficient is equal or less than 0/1 compatibility in judgments is acceptable otherwise it should be revise again. On the other hand comparison twin criteria matrix should set again:

Compatibility index $I.I. = \frac{\lambda_{\max} - n}{n - 1}$

Collision index with concern to number of criteria’s (n) can take from this table:

<table>
<thead>
<tr>
<th>N</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.I.</td>
<td>0</td>
<td>0/58</td>
<td>0/9</td>
<td>1/12</td>
<td>1/24</td>
<td>1/32</td>
<td>1/41</td>
<td>1/45</td>
<td>1/49</td>
<td>1/51</td>
<td>1/48</td>
<td>1/56</td>
<td>1/57</td>
<td>1/59</td>
</tr>
</tbody>
</table>
At last rate of incompatibility matrixes are coming for this formula:

\[ \text{Incompatibility rate matrixes} = I.R_1 = \frac{I.R}{R.I} \]

1. **Relative weight criteria’s (indexes) in construction phase for Tehran oil refinery**

With use of geometrical average twin comparisons matrix were calculated. In this method, after provide the twin comparisons matrix, first geometrical average of each line of matrix is calculate, second the column matrix obtained will divided of each indexes to sum of all existing indexes will normalized for correct result. The new column matrix obtained is weighted matrix of concern indexes. The calculation method is here.

\[
\begin{bmatrix}
  a_{11} & \cdots & a_{1n} \\
  \vdots & \ddots & \vdots \\
  a_{n1} & \cdots & a_{nn}
\end{bmatrix}
\rightarrow
\begin{bmatrix}
  \sqrt[n]{a_{11} \cdots a_{1n}} \\
  \vdots \\
  \sqrt[n]{a_{n1} \cdots a_{nn}}
\end{bmatrix}
\rightarrow
\begin{bmatrix}
  \frac{\pi_1}{\sum_{i=1}^{n} \pi_i} \\
  \vdots \\
  \frac{\pi_n}{\sum_{i=1}^{n} \pi_i}
\end{bmatrix}
\rightarrow
\begin{bmatrix}
  W_1 \\
  \vdots \\
  W_n
\end{bmatrix}
\]

In this research four main indexes determined in order to priority for main indexes of environmental impact assessment of Tehran oil refinery. The decision maker twin criteria matrix is in the table 3.

**Table 3 Twin criteria matrix of main indexes of this research**

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Economical</th>
<th>Land Use</th>
<th>Environmental</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>1</td>
<td>1.4</td>
<td>2.9</td>
<td>3</td>
</tr>
<tr>
<td>Land Use</td>
<td>0.71</td>
<td>1</td>
<td>4.9</td>
<td>2</td>
</tr>
<tr>
<td>Environmental</td>
<td>0.34</td>
<td>0.2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Social</td>
<td>0.33</td>
<td>0.5</td>
<td>0.5</td>
<td>1</td>
</tr>
</tbody>
</table>

Step one: Preparing the data
First choice of high-performance functions for linguistic variables defined above, and input and output data sets in each stage, the preparation is a process that input and output functions related to participation. I therefore prepared a set of diagrams that show different levels in the decision. Each value in the decision making level in a series of 100 percent 1 to 0% for 0 to join the membership will change. This means that only one of the absolute value Is true is false and all other values, a set Decision making that values it at all values of It is true that from 100% to 0% change. The logic toolbox decision-making software, input and input variable is always on the enamel a numeric value.

Step two: Applying the logical operator
After preparation of the variable input and output functions using decision rules, which can output to a number is obtained higher or lower than the input number.
Step three: Inference rules for decision-making
Control systems are inference rules of decision and rule base, which is a set of rules and decisions are relating to the collection, input and output values. Before applying the inference method, the weights for the (grade 0 to 1) are defined by any law. According to the rules of weight is specified at a minimum level. For example, weight one, to maximum has no effect on output, to exert influence in the relationship between the rules should give the number except one.

Step Four: Merge all outputs and results summarized
Since the decision is with regard to all laws, rules must be in total output are merged, at this stage, the results were not applied for any law to be performed in parallel.

Step Five: TOPSIS (Technique for Order Preference by Similarity to the Ideal Solution)
- In this method two artificial alternatives are hypothesized.
- Ideal alternative: the one which has the best level for all attributes considered.
- Negative ideal alternative: the one which has the worst attribute values.
- TOPSIS selects the alternative that is the closest to the ideal solution and farthest from negative ideal alternative.

Input to TOPSIS
- TOPSIS assumes that we have m alternatives (option) and n attributes / criteria and we have the score of each option with respect to each criterion.
- Let xij score of option I with respect to criterion j we have a matrix X=(xij) m*n matrix.
- Let J be the set of benefit attributes or criteria (more is better)
- Let J' be the set of negative attributes or criteria (less is better)

Steps of TOPSIS
- Step 1: Construct normalized decision matrix.
- This step transforms various attribute dimensions into non-dimensional attributes, which allows comparisons across criteria.
- Normalize scores or data.

\[
    r_{ij} = \frac{x_{ij}}{\sqrt{\sum x_{ij}^2}} \text{ for } i = 1, \ldots, m; \ j = 1, \ldots, n
\]

Other steps of TOPSIS were out of the studies so they did not use.

- Case studies
In this part Tehran and Isfahan oil refineries were selected. The decisions data due to quantitative were normalized in the part of environmental studies with TOPSIS; step-1. Other data form economical, social and land use studies due to qualitative were put in the software. All Studies were carried out with consideration of cities and villages near by these oil refineries, their environmental characteristics, environmental, economical, and social and land use effects of oil refineries on the cities and villages near by them.

- Tehran oil refinery
Oil refinery and environment interactions were studied given the size of the job and environmental features in the framework of different units of an oil refinery (executive, constructional, operational and processing) and different environmental (physical, biological, socio-economical and cultural) parameters. The major environmental impacts and consequences of oil refineries include gas emissions, effluents, solid wastes, noise, odor and negative visional and aesthetic impacts (Ardalanie, 1989).
The following are the details of the oil refinery facility of the case study:
Name: Tehran Oil refining Co.
Date of establishment: 1965-1968
Date of operating: 1969 (South refinery) - 1973 (North refinery)
Nominal capacity: 220,000 barrels per day
Operational capacity: 240,000 barrels per day
Feed: Light crude oil of Ahvaz – Asmari oil field, crude oil of Maroon/Shadgan, Middle Asia
Production units: Crude oil distillation, viscosity control unit, liquid gas recovery, gasoline hydrogenated refining and gasoline conversion, hydrocracker, Hydrogen, Nitrogen, Sulfur recovery, Amine gas treatment (Khosravanie, 2001).

Table 4 Tehran oil refinery productions

<table>
<thead>
<tr>
<th>Product</th>
<th>Real average of products</th>
<th>Capacity (1000 liter per day) product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid gas</td>
<td></td>
<td>1259</td>
</tr>
<tr>
<td>Gasoline</td>
<td></td>
<td>1700</td>
</tr>
<tr>
<td>Jet fuel</td>
<td></td>
<td>6989</td>
</tr>
<tr>
<td>Light Naphta</td>
<td></td>
<td>383</td>
</tr>
<tr>
<td>Kerosene</td>
<td></td>
<td>3442</td>
</tr>
<tr>
<td>Gas oil</td>
<td></td>
<td>12872</td>
</tr>
<tr>
<td>Furnace oil</td>
<td></td>
<td>7549</td>
</tr>
<tr>
<td>Crude engine oil</td>
<td></td>
<td>1878</td>
</tr>
<tr>
<td>Bitumen production feed</td>
<td></td>
<td>2160</td>
</tr>
</tbody>
</table>

Source: Iranian petroleum ministry

Environmental impact assessment of oil refinery in Iran is one of the most important parts for the environmental protection. So the scope of this project can contain all the oil refineries in Iran because all of the oil refineries have similar action and their products are the same. So the scope for this project can cover all the oil refineries in Iran for environmental impacts assessment and knowledge of environmental management for oil refineries to help protect the environment. Table 3.16 shows the activities of operation phase of Tehran oil refinery. The operational phase is under test and the productions and materials need to quality control as technical programming and flow sheet of major unit operations and material balance flow is under revise for till getting better results of productions.

- Isfahan oil refinery

Esfahan Oil Refining Company's activities in the field of refining crude oil and oil products production and energy security of downstream industries (Esfahan Petrochemical Company, Arak Petrochemical, Sepahan oil refining plant, Jay oil Refining industries and other chemical industries in Iran) began in 1979 and it is now proceeds about 23% of the petroleum products required to produce. The total area of 340 hectares in area and having green space area 5 /114 acres is located in the northwest of Isfahan. Isfahan refinery has seen much progress of crude oil refining per day, so much products in the early 90's, and crude oil refining capacity of the company increased 85% compared to the design capacity of 200 thousand barrels per day has increased to more than 375 thousand barrels (Khosravanie, 2001).
Production of Isfahan oil refinery
This refinery has many productions that come in the table below. Table 3.17 Isfahan oil refinery productions.

Table 5 Isfahan oil refinery productions

<table>
<thead>
<tr>
<th>Real average of products</th>
<th>Capacity (1000 liter per day) product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid gas</td>
<td>1173</td>
</tr>
<tr>
<td>Gasoline</td>
<td>1600</td>
</tr>
<tr>
<td>Jet fuel</td>
<td>5980</td>
</tr>
<tr>
<td>Light Naphta</td>
<td>434</td>
</tr>
<tr>
<td>Kerosene</td>
<td>5221</td>
</tr>
<tr>
<td>Gas oil</td>
<td>13264</td>
</tr>
<tr>
<td>Furnace oil</td>
<td>8549</td>
</tr>
<tr>
<td>Crude engine oil</td>
<td>1998</td>
</tr>
<tr>
<td>Bitumen production feed</td>
<td>3180</td>
</tr>
<tr>
<td>Sulfur</td>
<td>4567</td>
</tr>
<tr>
<td>Light oil</td>
<td>17323</td>
</tr>
<tr>
<td>Heavy oil</td>
<td>14562</td>
</tr>
</tbody>
</table>

Source: Iranian petroleum ministry

- Importance of environmental measures of Isfahan oil refinery
- The project of oil leak into the soil and groundwater surrounding the refinery:
  A-Control of oil pollution of groundwater samples from monitoring wells forty
  B-Installation of more than 300 gas sampling hole (GSH) for measuring the gas in the soil
  C- Order to buy and set gas meter - GPS - interface meter for oil spill project
  2-The dredging project to extract oil from oil sludge tanks
  3-Projects to reduce emissions of ozone depleting gases and replacing fire and refrigeration systems
  4-Make contracts with trusted environmental laboratories for their project statements and monitoring of air pollutants, wastewater and solid waste management company in the quarter for four years.
  5-Several environmental research projects (API odors - The use of urban wastewater treatment plants and industrial purposes .... City Shahinshahr)
  6-Conservation of the 5/114 hectares of green space
  7-Active participation in making landfill monitoring with environmental standards in the local areas

-Mega Projects in Execution
1- Gasoline Production Plant (G .P .P)
The project includes the construction of three units: CCR, NHT and Isomerisation are in progress by the engineering firm plans. The achievements of this project are summarized as follows:
  a. Increased the refinery gasoline production rate of 3 million liters per day; then the gasoline produced by the refinery of 9 million liters to 12 million liters per day increases.
  b. Increase gasoline quality produced by the refinery and Increase octane gasoline production from 87 to 93.
c. Reduce Imports 3/3 million liters of super gasoline per day to Iran and cut the need of gasoline imports to Isfahan refinery.
d. The possibility of super gasoline production in Isfahan oil refinery.

2- Upgrading & Revamping Project (U. R. P)
The project includes the construction these units: third LPG unit, CDU unit and revamp of existing units and replacing the control system of refinery. The project is not only to optimize refinery operations and safety issues will also meet the operational units and the main part of the meal will be provided downstream units. The achievements of this project are summarized as follows:
a. Eliminate operating problems, improving communication paths within the refinery, the construction of new reservoirs of gas feed line and the communication between the refinery and the southern part of units.
b. Replacement of existing pneumatic control system with advanced control system in existing units and monitor all activities via a central control room.
c. Installation the new instruments and operational systems in all units of refinery.

3- Upgrading Project (U.P)

Planning and installation of new refining utilities are in the south of oil refinery. The execution of this project based on the Bottom of the Barrel plan and it will follow the Heavy product & Residue Conversion method and it will Minimum Fuel Oil production.

- Reasons of TEHRAN and ISFAHAN oil refineries as case studies for study of EIA of oil refineries in IRAN
  - To identify and eliminate of all wrong activities of the environmental impact assessment
  - To make the correct way for increase activities in accordance with the environmental impact assessment
  - To make systematic pollution control planning for environmental protection
  - To act on proper environmental planning in one the most important oil refineries in Iran
  - To provide integrated environmental management plan for control the adverse activities
  - To prepare an integrated modeling for environmental impact assessment
  - To provide a framework for evaluating the oil refinery effects on environment
  - To identify the economic-environmental indicators and effects
  - To identify the social–environmental indicators and effects
  - To review land use indicators and effects in the area around the oil refinery
**Result and discussion**

**Figure 1** Tehran oil refinery construction phase

After modeling in Expert choice 11 and login the paired comparisons matrices, weight criteria’s and sub-criteria in the method as follow was obtained. In the figure 1 the main priority of Environmental impact assessment in Tehran oil refinery in the construction phase with Expert choice 11 software. As can be seen in Table 4 environmental criteria with relative weight 0.45 is the most important criteria. Thus the environmental criterion is the main elements of the environmental impact assessment of the oil refinery are most effective. A social criterion with relative weight 0.29 is in the next priority. Rate comparison incompatible pair obtained as 0/05 that because it is less than 0/1 compatibility of these comparisons is acceptable.

**Table 6** Paired comparison matrix non measurement scaling and relative weight in construction phase of Tehran oil refinery

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Prioritize</th>
<th>relative weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>3</td>
<td>0.15</td>
</tr>
<tr>
<td>Land Use</td>
<td>4</td>
<td>0.11</td>
</tr>
<tr>
<td>Environmental</td>
<td>2</td>
<td>0.45</td>
</tr>
<tr>
<td>Social</td>
<td>1</td>
<td>0.29</td>
</tr>
</tbody>
</table>
**Figure 2** Prioritization of major criteria environmental impact assessment of Tehran oil refinery construction phase in Iran with expert choice 11 software

![Prioritization of major criteria](image)

**Figure 3** Compare the relative importance for Tehran oil refinery-operation phase

![Compare the relative importance](image)

**Figure 4** Compare the relative importance for Tehran oil refinery

![Compare the relative importance](image)

After modeling in Expert choice 11 and login paired comparisons matrices, weight criteria and sub-criteria were obtained in figure 2. The main priority of Environmental impact assessment in Tehran oil refinery in operation phase can be seen with Expert choice 11. As in table 6 can be seen an environmental criterion with relative weight 0/38 is the most important, thus the main elements of the environmental impact assessment of the oil refinery is most effective. A social criterion with relative weight 0/33 is in the next priority. Rate of comparison incompatible pair is 0/007 that because is less than 0/1 this comparison is reasonable consistency.
Table 7 The non measurement scaling and the relative weights of the main criteria in the operation phase for Tehran oil refinery

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Prioritize</th>
<th>relative weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>3</td>
<td>0.184</td>
</tr>
<tr>
<td>Land Use</td>
<td>4</td>
<td>0.110</td>
</tr>
<tr>
<td>Environmental</td>
<td>1</td>
<td>0.377</td>
</tr>
<tr>
<td>Social</td>
<td>2</td>
<td>0.329</td>
</tr>
</tbody>
</table>

Figure 5 Prioritization of environmental impact assessment of Tehran oil refinery operation phase with Expert choice 11 software.

3. The relative weights of the criteria (indicators) in construction phase for Isfahan oil refinery

In this study, four major criteria in order to prioritize the main elements of the environmental impact assessment the oil refinery has been detected in the matrix of paired comparisons decision maker is in Table 7.

Table 8 The main criteria of paired comparisons matrix in construction phase for Isfahan oil refinery

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Economical</th>
<th>Land Use</th>
<th>Environmental</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Land Use</td>
<td>0.5</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Environmental</td>
<td>0.33</td>
<td>0.5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Social</td>
<td>0.25</td>
<td>0.33</td>
<td>0.5</td>
<td>1</td>
</tr>
</tbody>
</table>
Figure 6 Prioritize of Isfahan oil refinery in construction phase

![Prioritize of Isfahan oil refinery in construction phase](image1)

Figure 7 Compare relative importance of Isfahan oil refinery in construction phase

![Compare relative importance of Isfahan oil refinery in construction phase](image2)

After entering the model in Expert Choice 11 software and paired comparisons matrix, criteria and sub-criteria weights in a way that is shown below, respectively. In the figure 8 prioritize main elements of the environmental impact assessment of Isfahan oil refinery in the construction phase is shown in the Expert Choice 11 software. As can be seen in table 8, with the economical measure the relative weight of 0.47 is most important, thus the main element of the environmental impact assessment of the oil refinery is most effective element. Land use element with relative weight of 0.28 is the next priority. Rate of paired comparisons found that the inconsistency rate of 0.01 is less than 0.1; the compatibility of these comparisons is acceptable.

Table 9 Non measurement scale matrix and relative weights of the main criteria in construction phase for Isfahan oil refinery

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Prioritize</th>
<th>relative weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>1</td>
<td>0.467</td>
</tr>
<tr>
<td>Land Use</td>
<td>2</td>
<td>0.277</td>
</tr>
<tr>
<td>Environmental</td>
<td>3</td>
<td>0.160</td>
</tr>
<tr>
<td>Social</td>
<td>4</td>
<td>0.095</td>
</tr>
</tbody>
</table>
**Figure 8** Prioritization of major criteria in environmental impact assessment Isfahan oil refinery in operation phase by using Expert choice 11 software

4. The relative weights of the criteria (indicators) in operation phase for Isfahan oil refinery

In this study, four major criteria in order to prioritize the main elements of the environmental impact assessment the oil refinery has been detected in the matrix of paired comparisons the decision maker is in Table 9.

**Table 10** The main criteria of the paired comparisons matrix of Isfahan oil refinery in operation phase

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Economical</th>
<th>Land Use</th>
<th>Environmental</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Land Use</td>
<td>0.5</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Environmental</td>
<td>0.33</td>
<td>0.33</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Social</td>
<td>0.25</td>
<td>0.25</td>
<td>0.33</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 9** Comparing relative elements in Isfahan oil refinery in operation phase

**Figure 10** Compare the relative importance in Isfahan oil refinery in operation phase
After modeling in Expert choice 11 and login paired comparisons matrices, weight criteria and sub-criteria were obtained in figure 11. The main priority of Environmental impact assessment in Isfahan oil refinery in operation phase can be seen with Expert choice 11. As in table 10 can be seen an economical criterion with relative weight 0.45 is the most important, thus the main elements of the environmental impact assessment of the oil refinery is most effective. A land use criterion with relative weight 0.32 is in the next priority. Rate of comparison incompatible pair is 0.05 that because is less than 0.1 this comparison is reasonable consistency.

Table 11 Non measurement scale matrix and relative weights of the main criteria in construction phase for Isfahan oil refinery in operation phase for Isfahan oil refinery

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Prioritize</th>
<th>relative weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>3</td>
<td>0.45</td>
</tr>
<tr>
<td>Land Use</td>
<td>4</td>
<td>0.32</td>
</tr>
<tr>
<td>Environmental</td>
<td>1</td>
<td>0.16</td>
</tr>
<tr>
<td>Social</td>
<td>2</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Figure 11 The main priority of environmental impact assessment of Isfahan oil refinery in operation phase

5. Comparisons between the two oil refineries (Tehran oil refinery and Isfahan oil refinery)

Figure 12 AHP compare of Tehran and Isfahan oil refineries
Orange color: Tehran oil refinery  
Blue color: Isfahan oil refinery  
In the figure 12 it can be seen the compare of every major elements of two oil refineries in Iran.

**The results for GIS-EIA Tehran oil refinery**

Obviously, the implementation of GIS in any organization is its complexity. As studied in this project for Tehran oil refinery the successful result of study is coming for final action plan of GIS-EIA. However, for the successful implementation of a system for GIS-EIA, the following actions should be taken as follow;

- Requirements Analysis of EIA oil refinery.
- Implementation of a pilot project (Pilot) for more accurate identification of needs and problems, in this case Tehran oil refinery.
- Conceptual design, logical and physical database.
- Maps, drawings and specifications needed to produce guidelines.
- Produce a map and descriptive information collection requirements.
- Design and implementation of GIS-EIA of oil refinery.
- Providing hardware and software requirements, and training of personnel.
- Development of the database is designed to cover specific applications for the system.
- Application development and data analysis functions.
- Development of information exchange standards and processes
- Development the GIS-EIA and the development and maintenance of information processing of EIA.
- Full implementation of GIS-EIA as integrated systems in other operational units and dependent organizations same as workshops, material shops and personnel.
- Full implementation of GIS-EIA as Environmental and Social Action Plan (ESAP) as effects of oil refineries in social parameters same as; historical, environmental knowledge, cultural problems.

http://www.ijhcs.com/index.php/ijhcs/index
- Development of GIS-EIA as land use parameters and its effects on population and environment.
- Design and implementation of GIS-EIA as economical parameters such as workshops, material industrial equipments & material shops.
- Development of GIS-EIA as environmental parameters base on the lab tests and their effects on the located area on the maps.

In this project GIS-EIA of Tehran oil refinery and effects on located areas around it (Azim abad, Bagher city, Dorsoun abad, Esmaeil abad-e-moein) different parameters (economical, environmental, land use and social) have been considered to provide the maps based on data collections, expert system decision-makers and GIS information. All these areas pointed on the maps and sat-images of their area on the GIS-EIA study of each oil refinery.

**Table 12** Different parameters maps of Tehran oil refinery and located area around it during the project implementation (2008-2012)

<table>
<thead>
<tr>
<th>Location</th>
<th>Economical</th>
<th>Environmental</th>
<th>Land use</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azim abad</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>Bagher city</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>Dorsoun abad</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>Esmaeil abad-e-moein</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>Total maps</td>
<td>144</td>
<td>112</td>
<td>112</td>
<td>144</td>
</tr>
</tbody>
</table>

All maps designed and implementation of four parts of GIS-EIA of oil refineries as case studies, Tehran oil refinery. Total maps of this project are 1024 maps for two case studies in four years by developing of four parameters effects on their locations.

**Table 13** Different kinds of GIS maps provided for each case study during the project implementation-Tehran oil refinery (2008-2012)

<table>
<thead>
<tr>
<th>Special Geographical GIS maps</th>
<th>Numbers of maps of Tehran oil refinery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azim abad</td>
<td>Bagher city</td>
</tr>
<tr>
<td>Hill shade</td>
<td>16</td>
</tr>
<tr>
<td>Layers</td>
<td>16</td>
</tr>
<tr>
<td>Land use</td>
<td>16</td>
</tr>
<tr>
<td>Sat-image</td>
<td>16</td>
</tr>
<tr>
<td>Slope</td>
<td>16</td>
</tr>
<tr>
<td>Tin</td>
<td>16</td>
</tr>
</tbody>
</table>
The criteria used to determine the score and weight maps for each of the criteria and sub-criteria classification in Expert choice 11 the achieved weight in preparation software. After the raster with Raster calculator in Arc GIS 9.3 they have been overlapped. Figure 6 Map of weighting factors for each of the above shows. Figure 7 to 10 Final plans zoning EIA-Tehran oil refinery as digital displays for construction phase and figure 11 to 14 final plans zoning EIA-Tehran oil refinery as digital displays for operation phase. The map of the objectives are in the study and use of software EIA and effective points in the region with four exciting classification, low, moderate, high, extremely high.

<table>
<thead>
<tr>
<th>Zoning</th>
<th>16</th>
<th>16</th>
<th>16</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total maps</td>
<td>112</td>
<td>112</td>
<td>112</td>
<td>112</td>
</tr>
</tbody>
</table>

**Figure 13** Economical parameter (2008-2012)  
**Figure 14** Land use (2008-2012)
Figure 15 Environmental parameter (2008-2012)

Figure 16 Social parameter (2008-2012)
Obviously, the implementation of GIS in any organization is its complexity. As studied in this project for Isfahan oil refinery the successful result of study is coming for final action plan of GIS-EIA. However, for the successful implementation of a system for GIS-EIA, the following actions should be taken as follow;

- Requirements Analysis of EIA oil refinery.
- Implementation of a pilot project (Pilot) for more accurate identification of needs and problems, in this case Isfahan oil refinery.
- Conceptual design, logical and physical database.
- Maps, drawings and specifications needed to produce guidelines.
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- Design and implementation of GIS-EIA of oil refinery.
- Providing hardware and software requirements, and training of personnel.
- Development of the database is designed to cover specific applications for the system.
- Application development and data analysis functions.
- Development of information exchange standards and processes
- Development the GIS-EIA and the development and maintenance of information processing of EIA.
- Full implementation of GIS-EIA as integrated systems in other operational units and dependent organizations same as workshops, material shops and personnel.
- Full implementation of GIS-EIA as Environmental and Social Action Plan (ESAP) as effects of oil refineries in social parameters same as; historical, environmental knowledge, cultural problems.
- Development of GIS-EIA as land use parameters and its effects on population and environment.
- Design and implementation of GIS-EIA as economical parameters such as workshops, material industrial equipments & material shops,
- Development of GIS-EIA as environmental parameters base on the lab tests and their effects on the located area on the maps.

In this project GIS-EIA of Isfahan oil refinery GIS-EIA part in most effective areas around it (Dehno, Khomeynishahr, Mahmoud abad, Shahinshahr) and different parameters (economical, environmental, land use and social) have been considered to provide the maps based on data collections, expert system decision-makers and GIS information. All these areas pointed on the maps and sat-images of their area on the GIS-EIA study of each oil refinery.

Table 14 Different parameters maps of Isfahan oil refinery and located area around it during the project implementation (2008-2012)

<table>
<thead>
<tr>
<th>Location</th>
<th>Economical</th>
<th>Environmental</th>
<th>Land use</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehno</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>Khomeynishahr</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>Mahmoud abad</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
</tr>
</tbody>
</table>
All maps designed and implementation of four parts of GIS-EIA of oil refineries as case studies, Isfahan oil refinery. Total maps of this project are 1024 maps for two case studies in four years by developing of four parameters effects on their locations.

**Table 15** Different kinds of GIS maps provided for each case study during the project implementation-Isfahan oil refinery (2008-2012)

<table>
<thead>
<tr>
<th>Special Geographical GIS maps</th>
<th>Numbers of maps of Isfahan oil refinery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dehno</td>
</tr>
<tr>
<td>Hill shade</td>
<td>16</td>
</tr>
<tr>
<td>Layers</td>
<td>16</td>
</tr>
<tr>
<td>Land use</td>
<td>16</td>
</tr>
<tr>
<td>Sat-image</td>
<td>16</td>
</tr>
<tr>
<td>Slope</td>
<td>16</td>
</tr>
<tr>
<td>Tin</td>
<td>16</td>
</tr>
<tr>
<td>Zoning</td>
<td>16</td>
</tr>
<tr>
<td>Total maps</td>
<td>112</td>
</tr>
</tbody>
</table>

Final zoning map for Isfahan oil refinery are available for construction and operation phase in economical, environmental, land use and social parameters.
Figure 19 Environmental parameters (2008-2012)

Figure 20 Economical parameters (2008-2012)

Figure 21 Social parameters (2008-2012)

Figure 22 Land use parameters (2008-2012)
Conclusion

Environmental impact assessment method for oil refineries and its software will be used as a multi-criteria decision-making support tool for integrating the opinions of many experts on selection of the best alternative. There are three modules of the software:

Category 1: Site selection
The most important issues with regard to potential impacts which shall be considered when selecting the site of a refinery are:
- Supplying consuming water and its proper quality and quantity to meet refineries needs and filtering the water received
- A piece of land large enough to establish facilities and equipment including raw materials tanks, manufacturing, maintenance, and disposal of wastes and facilities of the future development
- Proper distance from the surrounding land uses such as residential, commercial, administrative, recreational, and tourism areas to avoid nuisance or air pollution impacts, odor, noise, explosion, and firing risks
- Proper topography to reduce adverse climatic consequences

Figure 23 EIA Isfahan oil refinery final weightings map in construction phase during (2008-2012)

Figure 24 EIA Isfahan oil refinery final weightings map in operation phase during (2008-2012)
- Minimum risks of occurrence of natural disasters
- Not being located in the areas which are effective on feeding the underground waters
- Proper distance from the cultural areas in order not to be exposed to the refinery outlets

Category 2: Transporting Materials
Leakage of oil caused by transports is one of the main environmental problems of refineries. Transporting raw materials to refineries and/or transferring of manufacturing products from these units potentially result in unexpected accidents such as breaking pipelines, leakage of transport tankers, loading or unloading. Occurrence of such accidents depends on infrastructures, ecological and geographical conditions, and the topography of transport routes. Thus, considering the above, equipment, methods, and routes which cause the least ecological and environmental risks shall be chosen in spite of costly systems and/or routes. Installation of pipeline on the ground and/or under the ground from a plant to the source of supplying raw materials and using tankers, railways, and heavy vehicles shall be considered as some options to reduce the effects of transport.

Category 3: Processes
In most cases, choosing production process options which are possible to be applied in the environment are difficult. Choosing possible processes in the present and future conditions to reduce environmental impacts are studied as follows:
- Substitution of long-life catalysts with less production frequency
- Substitution of air cooling fans for cooling water to reduce the effects of discharging the water of coolers

One site characteristics and its location are digitized from paper map files to software form for make it as software package that can be viewed in the system. All information about this issue entails three categories of operations refers to Tehran oil refinery:
1. Detailed investigations and studies about the environment.
2. Investigations and studies about oil refineries.
3. Investigations and studies about oil refineries’ environmental impacts assessment

With regard to the first item above, studies were done aimed at protecting the surrounding vegetation near oil refineries.

With regard to the second item above, studies were done about major pollutants released by oil refineries into the areas nearby. In this study different parts of oil refineries were taken into account.

With regard to the third item above, different products of crude oil were considered as a source of pollution in case a major technical problem occurs for oil refineries. The danger of such a probable technical problem is present in all the stages of design, construction or operation of oil refineries.

During the investigations, the different features of establishing a refinery including construction and operating stages, the various environmental features including physical, biological, socio-economical and cultural environments had been studied. The interactions among features and parameters were studied too. These studies and investigations were performed in two parts of refinery constructional and operational activities. Environmental features were taken into consideration in the framework of categories designated as physical, biological, social-economical and cultural environments. Also given the various construction and operating stages, the interactions among environment and operations were studied.
Acknowledgement
The studies consists of these stages results.
-Stage one: in model view; economical, environmental, land use and social parameters have been weighted.
-Stage two: for construction and operation priorities with respect to: economical, environmental, land use and social parameters in case of Tehran and Isfahan oil refineries.
-Stage three: For compare of AHP construction and operation priorities with respect to: economical, environmental, land use and social parameters in case of Tehran and Isfahan oil refineries.
-Stage four: For compare of GIS in construction and operation priorities with respect to: economical, environmental, land use and social parameters in case of Tehran and Isfahan oil refinery.
References